

## Lecture Module - Introduction

ME3023 - Measurements in Mechanical Systems

Mechanical Engineering

Tennessee Technological University

### Topic 1 - Introduction

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- Topic 1 - General Measurement System
- Topic 2 - Types of Variables
- Topic 3 - Experimental Test Plan
- Topic 4 - Numbers and Storage

## Topic 1 - General Measurement System

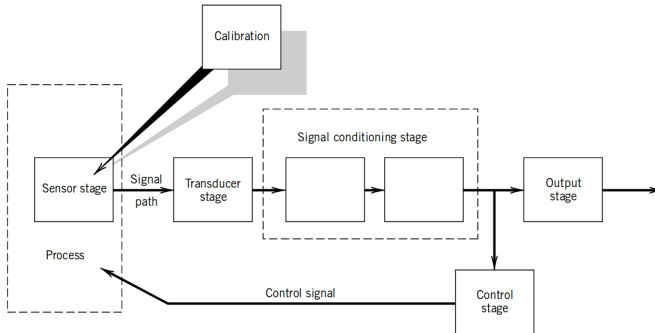
- Definition of a Measurement
- Measurement System Stages
- Brainstorming Activity
- Examples in Mechanical Engineering

# Definition of a Measurement

“A **measurement** is an act of assigning a specific value to a physical variable.”

Text: Theory and Design of Mech. Meas.

# Measurement System Stages

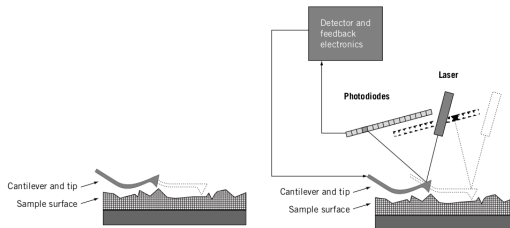


**Figure 1.5** Components of a general measurement system.

Image: Theory and Design of Mech. Meas.

## Sensor-Transducer Stage

a **sensor**, a physical element that employs some natural phenomenon... ..to sense the variable being measured

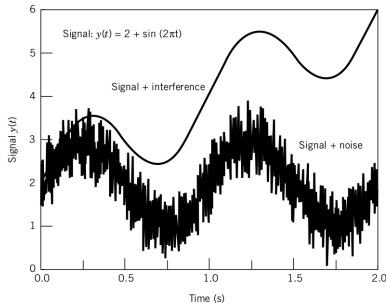


A **transducer** converts the sensed information into a detectable signal

Text, Image: Theory and Design of Mech. Meas.

# Signal Conditioning Stage

What is the the definition of **signal**?



- Filtering
- Amplification
- Attenuation
- Excitation
- Linearization
- Electrical Isolation
- Surge Protection

Image: Theory and Design of Mech. Meas.

# Output Stage

The **output stage** indicates or records the value measured. This might be a simple readout display, a marked scale, or even a recording device such as a computer disk drive.

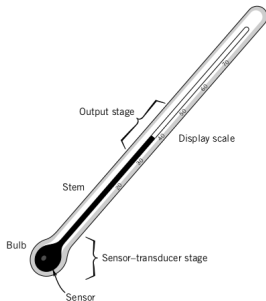


Image: Theory and Design of Mech. Meas.

Image: [Wikipedia](#)



# Numbers and Storage

**Activity:** Team Brainstorm  
**Duration:** ~ 10 minutes  
**Groups:** 2-3 members



**Topic:** Remote Probe Concept

- You are designing a remote probe to inspect an environment which can only be accessed from above.
- The goal is to collect as much information as possible from the environment to prepare for a robotic maintenance task.

## Requirements:

- Probe must enter environment through hole ~ 100mm wide
- Probe must exit through same hole leaving nothing behind
- The allowable EFI and RFI is limited. No wifi communication is available

# Numbers and Storage

IDETC2022-96785: Development of an Instrumented Rear Suspension to Measure the Tire Forces of a Race Car During Track Driving



# Numbers and Storage

IDETC2022-91154: Photometric Stereo Enhanced Light Sectioning  
Measurement for Microtexture Road Profiling



# Numbers and Storage

IDETC2022-90082: Automated Weld Path Generation Using  
Random Sample Consensus and Iterative Closest Point Workpiece  
Localization



## Topic 2 - General Measurement System

- Measured Variable
- Independent and Dependent Variables
- Controlled Variables and Parameters
- Extraneous Variables

# Measured Variable

“A **measurement** is an act of assigning a specific value to a physical variable. That physical variable is the **measured variable**.”

Text: Theory and Design of Mech. Meas.

# Independent and Dependent Variables

“If a change in one variable will not affect the value of some other variable, the two are considered independent of each other. A variable that can be changed independently of other variables is known as an **independent variable**. A variable that is affected by changes in one or more other variables is known as a **dependent variable**. Normally, the variable that we measure depends on the value of the variables that control the process.”

Text: Theory and Design of Mech. Meas.

# Controlled Variables and Parameters

“A variable is **controlled** if it can be held at a constant value or at some prescribed condition during a measurement... ...complete control of a variable is not usually possible. We use the adjective **controlled** to refer to a variable that can be held as prescribed, at least in a nominal sense...

...we define a **parameter** as a functional grouping of variables. For example, a moment of inertia or a Reynolds number... ...A **parameter** that has an effect on the behavior of the measured variable is called a control parameter....”

Text: Theory and Design of Mech. Meas.



# Extraneous VariablesV

“Variables that are not or cannot be controlled during measurement but that affect the value of the variable measured are called **extraneous variables**. Their influence can confuse the clear relation between cause and effect in a measurement... ...The effects due to **extraneous variables** can take the form of signals superimposed onto the measured signal with such forms as **noise** and drift.”

Text: Theory and Design of Mech. Meas.

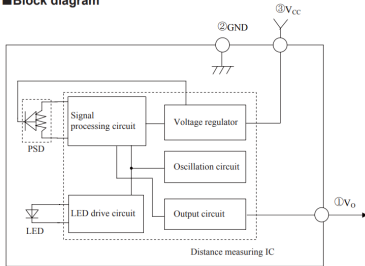
# Class Activity: Measurement System Examples

Individual Activity: Complete the activity and submit your work on ilearn as an *individual*.

## Example 1: SHARP IR Ranger



■ Block diagram



Identify the following measurement stages

- Sensor: \_\_\_\_\_
- Transducer: \_\_\_\_\_
- Signal Conditioning: \_\_\_\_\_
- Output: \_\_\_\_\_

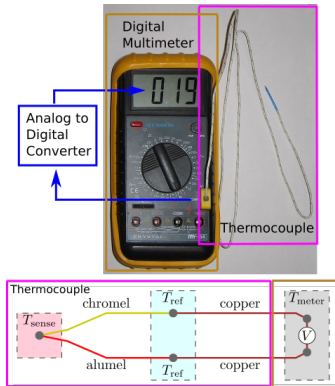
Name at least one for each of the following categories

- Measured Variable: \_\_\_\_\_
- Independent Variable(s):  
\_\_\_\_\_
- Dependent Variable(s):  
\_\_\_\_\_, \_\_\_\_\_
- Controlled Variable(s):  
\_\_\_\_\_, \_\_\_\_\_
- Extraneous Variable(s): \_\_\_\_\_

# Class Activity: Measurement System Examples

Individual Activity: Complete the activity and submit your work on ilearn *as an individual*.

## Example 2: Thermocouple with DMM



Identify the following measurement stages

- Sensor: \_\_\_\_\_
- Transducer: \_\_\_\_\_
- Signal Conditioning: \_\_\_\_\_
- Output: \_\_\_\_\_

Name at least one for each category

- Measured Variable: \_\_\_\_\_
- Independent Variable(s):  
\_\_\_\_\_
- Dependent Variable(s):  
\_\_\_\_\_
- Controlled Variable(s): \_\_\_\_\_
- Extraneous Variable(s): \_\_\_\_\_

Image, More Info: [Wikipedia](#)

# Numbers and Storage

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